## REMARKS

Claims 1-61 are pending herein, of which claims 16-61 have been withdrawn as being directed to a non-elected invention.

1. Claims 6-9 stand rejected under §112, second paragraph. Claim 6 has been amended to depend from claim 1 and include the limitations of claim 10. Claim 10 has been canceled. Applicants respectfully request withdrawal of this rejection.

2. Claims 6-10 stand rejected under §102(b) as being anticipated by Locher et al., "Large Diameter Sapphire Window from Single Crystal Sheets", *Proceedings of the Fifth DOD Electromagnetic Window Symposium*, Vol. 1 ("the Locher Article"). This rejection is respectfully traversed for the following reasons.

Claims 6-10 now depend directly or indirectly from claim 1. Claim 1 is directed to a sapphire single crystal comprising a single crystal sheet having a thickness not less than about 0.5 cm. The Locher Article discloses a thickness of 0.25 cm. The Locher Article does not teach each and every limitation of claim 1, and therefore, does not teach each and every limitation of claims 6-10. Therefore, the Locher Article cannot anticipate claims 6-10 at least for the reasons discussed with respect to claim 1. Applicants respectfully request withdrawal of the rejection of claims 6-10.

3. Claims 1-5 and 11-15 stand rejected under §103(a) over the Locher Article. This rejection is respectfully traversed for the following reasons.

A. Applicable Law

In order for claims 1-5 and 11-15 to be obvious over the Locher Article, the Locher Article must teach, suggest, or provide motivation to achieve the claimed invention. *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984). In addition, the Locher Article must enable one of ordinary skill in the art to make the sapphire single crystal comprising a single crystal sheet having the claimed thickness or $\Delta_T$. *Beckman Instruments, Inc. v. LKB Produckter AB*, 892 F. 2d 1547, 13 U.S.P.Q.2d 1301 (Fed. Cir. 1989). In order to assert that a parameter is a result-effective variable, the particular

parameter must first be recognized as a result-effective variable. M.P.E.P. 2144.05 II. B. In the following discussion, Applicants establish that the Office Action has failed to provide a *prima facie* showing of obviousness because the Locher Article does not teach, suggest, or enable achievement of the claimed invention. Also, Applicants have previously provided proof that the claimed invention is not enabled by the Locher Article, as well as a similar prior art reference (JP 57-095899 A), previously applied by the PTO. Further, Applicants have previously provided proof that the claimed thickness and $\Delta_T$ are not result-effective variables. The claimed thickness and $\Delta_T$ were achieved by Applicants making radical changes to the design of the crystal growth apparatus, not by merely optimizing the Locher process, such as by resizing existing components apparently argued by the PTO.

B. Claim Language

With respect to the particular claim language in the independent claims, each of claims 1 and 11 is directed to a large-sized sapphire single crystal, comprising a single crystal sheet having a width not less than 15 cm, a length greater than the width and a thickness not less than about 0.5 cm. Claim 12 recites an as-grown single crystal sheet, including a main body portion and a neck portion. The neck portion has a uniform construction as quantified by $\Delta_T$ as recited.

C. Introduction to the Locher Article and the Locher Declaration

Before the Present Application was filed, large single crystal sheets were investigated using the state of the art. However, merely desiring a result would not have meant that it could even remotely be achieved by the prior art. Here, the Locher Article does not teach, suggest, or enable achievement of the claimed thickness and $\Delta_T$, and the Locher Article does not enable the claimed thickness and $\Delta_T$. Applicants traverse the assertion in the Office Action that thickness and shape of the single crystal sheet are result-effective variables. The claimed thickness and $\Delta_T$ were only obtained after spending a substantial amount of time, money and effort that resulted in radical changes to the design of the crystal growth apparatus in order to produce the claimed single crystal sheets, not merely resizing existing components. Applicants have previously proven the importance of the crystal growth apparatus on the thickness and shape of the single crystal sheet. See Declaration Under 37 C.F.R. § 1.132 of John W. Locher ("the Locher Declaration").

Applicants note that John W. Locher is an author of the Locher Article and an inventor on the Present Application. Thus, Mr. Locher is intimately familiar with the content the Locher

Article and the Present Application. When the Locher Article was written, over 10 years before the filing date of the Present Application, Mr. Locher was an employee of Saphikon Inc., which later because part of Saint Gobain Ceramics & Plastics, Inc., which is the assignee of the Present Application.

D. High Aspect Ratio Crucible

In the context of the process flow described in the Locher Article, a conventional crucible was utilized, having a generally circular or round contour. See Paragraph 6 of the Locher Declaration. According to the Locher Article, length limitations were dictated primarily by the thickness and volume of the crucible. To obtain the larger sheet, the width dimension was scaled upward, that is, the size of the sheet and diameter of the crucible. See the Locher Article at Section 3.1, first paragraph. After reading the Locher Article, one of ordinary skill in the art would merely scale the size of the crucible to achieve a larger single crystal sheet. Thus, if thickness or shape was merely a result-effective variable, then merely scaling the size of the crucible would have been sufficient to obtain the claimed thickness and $\Delta_T$. Therefore, after reading the Locher Article and without looking to the Present Application, one of ordinary skill in the art would have scaled the size of the crucible, not radically changed the shape of the crucible.

Indeed, following an extension of the process flow of the Locher Article, the present inventors tried scaling the crucible to a larger size. Surprisingly, the present inventors discovered that scaled, round crucibles were a partial cause of failure to achieve crystals having the claimed features, notably thickness and $\Delta_T$. More specifically, it was discovered the scaled, round crucibles caused a non-uniform temperature gradient, reducing thickness, uniformity, and increasing $\Delta_T$.

> We discovered that in the migration from conventional crystal growing technology to larger-sized sheets, the conventional round crucibles inhibited our ability to achieve a uniform temperature gradient. See Locher Declaration at Paragraph 6, emphasis added.

As should be clear, the claimed thickness and $\Delta_T$ are not even remotely enabled by the Locher Article. The subsequent work by the Applicants showed that conventional round

crucibles did not achieve a single crystal sheet having the claimed thickness and $\Delta_T$ because a sufficiently uniform temperature gradient cannot be achieved.

E. Gradient Trim System

The Locher Article does not teach or suggest a crystal growth apparatus with a gradient trim system. In order to achieve the claimed thickness and $\Delta_T$, Applicants discovered use of a gradient trim system should be incorporated into the crystal growth apparatus. Applicants discovered that uniform thermal gradients are of particular importance in the successful growth of a large-sized, uniform thickness crystal that has uniform construction as quantified by a max $\Delta_T$. In particular, Applicants found that a non-uniform thermal gradient results in non-uniform growth of the crystal on the left side (center to left edge) relative to the right side (center to right side). This is particularly illustrated in crystal 80 shown in FIG. 6 of the Present Application, illustrating a notably large $\Delta_T$ associated with non-uniform thermal gradients.

Not only is a large $\Delta_T$ generally undesirable but also the large $\Delta_T$ can cause uncontrollable runaway process conditions during processing. More particularly, the Applicants discovered that the growing crystal functions as a heat sink, notably directing heat from the more massive portions of the crystal into the environment and into the crystal growing apparatus. In the particular example shown in FIG. 6, the thicker, higher mass left portion of the crystal functions to remove more heat from the system relative to the thinner, slower growing side of the crystal (right side). This causes a runaway process condition in which the crystal that is grown is very non-uniform, the left side becoming thicker and thicker, the right side being notably thin. Indeed, the process conditions may reach a point at which the crystal that is grown is completely unusable and of low thickness. Accordingly, the gradient trim system plays a notable role in the achievement of large-sized single crystal sheets having the claimed thickness and $\Delta_T$. See Paragraph 7 of the Locher Declaration.

The claimed thickness and $\Delta_T$ are not result-effective variables simply because some part of a crystal growth apparatus is present in the Patent Application. If the claimed thickness and $\Delta_T$ would have been result-effective variables, one of ordinary skill in the art, after reading the Locher Article and without looking to the Present Application, would have used a conventional crystal growth apparatus and resized one or more components accordingly, not radically changed the design of the crystal growth apparatus to incorporate a new gradient trim system. The Locher Article does not teach incorporating a new gradient trim system into the crystal growth

apparatus, and therefore, the Locher Article does not teach, suggest, or perhaps even more importantly, *enable* achievement of the claimed thickness and $\Delta_T$.

F. Heat Shield Assembly

The prior art shield assemblies were typically formed of a series of co-planar sheets, each having the *same* length and width. At best, the Locher article suggests to one of ordinary skill in the art resizing existing components of the crystal growth apparatus. Thus, after reading the Locher Article and without looking to the Present Application, at most, one of ordinary skill in the art would have changed the length and/or width of all the sheets. In this respect, Applicants tried using the prior art shield assembly design having enlarged heat shields of a non-stepped configuration. This design resulted in thermal profiles that did not allow the successful growth of large-sized sapphire single crystals having the claimed thickness and $\Delta_T$.

Based on the foregoing empirical studies, another radical change in the design of the present crystal growth apparatus is the use of a heat shield assembly having a stepped configuration. See, for example, the embodiment illustrated in FIG. 5, the shield assembly 26. This construction allows for reduced thermal profile adjustments during processing, which in turn contributes to the achievement of the claimed thickness and $\Delta_T$. Clearly, the claimed thickness and $\Delta_T$ are not result-effective variables because the design of the crystal growth apparatus was changed. The existing components were not merely resized.

G. Summary of Non-Obviousness Arguments

Claims 1-5 and 11-15 are not obvious over the Locher Article. The Locher Article describes an EFG-grown sapphire sheet having dimensions of 30.5 cm wide X 48 cm long X 0.25 cm thick. At best, the Locher Article suggests scaling dimensions of the existing components of the crystal growth apparatus to achieve thicker sheets of sapphire. The Locher Article does not teach or suggest that the design of the crystal growth apparatus would need to be fundamentally changed, which was developed by the present inventors only after exhaustive empirical studies. When the suggestion in the Locher Article to resize components was followed, a sapphire single crystal having the claimed thickness and $\Delta_T$ was not achieved. Thus, the claimed thickness and $\Delta_T$ would not have been obvious to one of ordinary skill in the art before the Present Application was filed. Further, the Locher Article does not enable achieving a sapphire single crystal comprising a single crystal sheet having the claimed thickness or $\Delta_T$

because attempts to use resized components of the crystal growth apparatus failed to produce a sapphire single crystal comprising a single crystal sheet having the claimed thickness or $\Delta_T$.

The claimed invention, which includes a sapphire single crystal comprising a single crystal sheet having the claimed thickness or $\Delta_T$, represents a notable leap in the size of single crystal sheets that can be achieved, and such a leap occurred due to a fundamental shift in crystal growth apparatus design. The assignee spent substantial amounts of money over several years collecting empirical data that provided information regarding thickness, thickness variation, and how thermal profiles affect the thickness and thickness variation. Only after such exhaustive study did Applicants discover how to obtain a sapphire single crystal comprising a single crystal sheet having the claimed thickness and $\Delta_T$. Notable changes in the design of the crystal growth apparatus allowed the sapphire single crystal comprising a single crystal sheet having the claimed thickness and $\Delta_T$ to be achieved. The changes were not trivial and did not come about by using predictive formulas to resize already existing components in the prior art apparatuses; the changes were empirical in nature.

H. Office Action of December 4, 2006

The Office Action asserts that thickness and shape are result-effective variables. However, the PTO does not support its assertion that the claimed thickness and $\Delta_T$ are result-effective variables. In contrast, the Applicants have submitted proof (the Locher Declaration), which establishes that the claimed thickness and $\Delta_T$ are not result-effective variables. A sapphire single crystal comprising a single crystal sheet having the claimed thickness and $\Delta_T$ only became possible after a notable shift in crystal growth apparatus design. For the reasons previously discussed, the claimed invention was not obtained by optimizing parameters through routine experimentation. For example, a sapphire single crystal comprising a single crystal sheet having the claimed thickness and $\Delta_T$ would not have been, and still cannot be, obtained merely by resizing existing components in a prior art crystal growth apparatus. In the absence of any proof to the contrary, the conclusory statements in the Office Action cannot withstand Board or appellate review.

Therefore, Applicants respectfully submit that claims 1, 11, and 12 would not have been obvious over the Locher Article. Claims 2-5, and 13-15 depend directly or indirectly from claim

1. Applicants respectfully submit that claims 2-5, and 13-15 would not have been obvious over the Locher Article at least for the reasons described with respect to claim 1.

For at least the foregoing reasons, Applicants submit that the presently claimed invention clearly defines over the art of record. Accordingly, reconsideration and withdrawal of the §103 rejection contained in the Office Action are respectfully requested.

Applicants respectfully submit that the present application is now in condition for allowance. Accordingly, the Examiner is requested to issue a Notice of Allowance for all pending claims.

Should the Examiner deem that any further action by the Applicants would be desirable for placing this application in even better condition for issue, the Examiner is requested to contact Applicants' undersigned attorney at the number listed below.

Applicants does not believe that any additional fees are due, but if the Commissioner believes additional fees are due, the Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 50-3797.

Respectfully submitted,

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